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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TELEPHONE TROUBLE BOOK

DISTRICT 1

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1943

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TELEPHONE TROUBLE BOOK.

Prepared by R. B. Adams, *Telephone Engineer, Forest Service.*

INTRODUCTION.

The following instructions covering the methods to be employed in locating and clearing telephone line and instrument trouble have been compiled for the use of Forest officers in District 1.

In order that these instructions may be of greatest value to the field force, including the temporary employees, it has been the endeavor to use simple language, avoiding as much as possible technical terms. By the use of numerous diagrams it is hoped that the text will be more readily understood.

THE TELEPHONE INSTRUMENT.

The standard telephone used by the Forest Service is the most powerful set obtainable for use under the conditions met within the National Forests. This set consists of a 5-bar generator, 2,500-ohm ringers, and a condenser in circuit with the receiver.

CIRCUITS IN A TELEPHONE.

There are three separate and distinct circuits in the ordinary wall telephone, but it is necessary to have these three circuits synchronized in order that the telephone may perform all the functions required of it. (See fig. 1.)

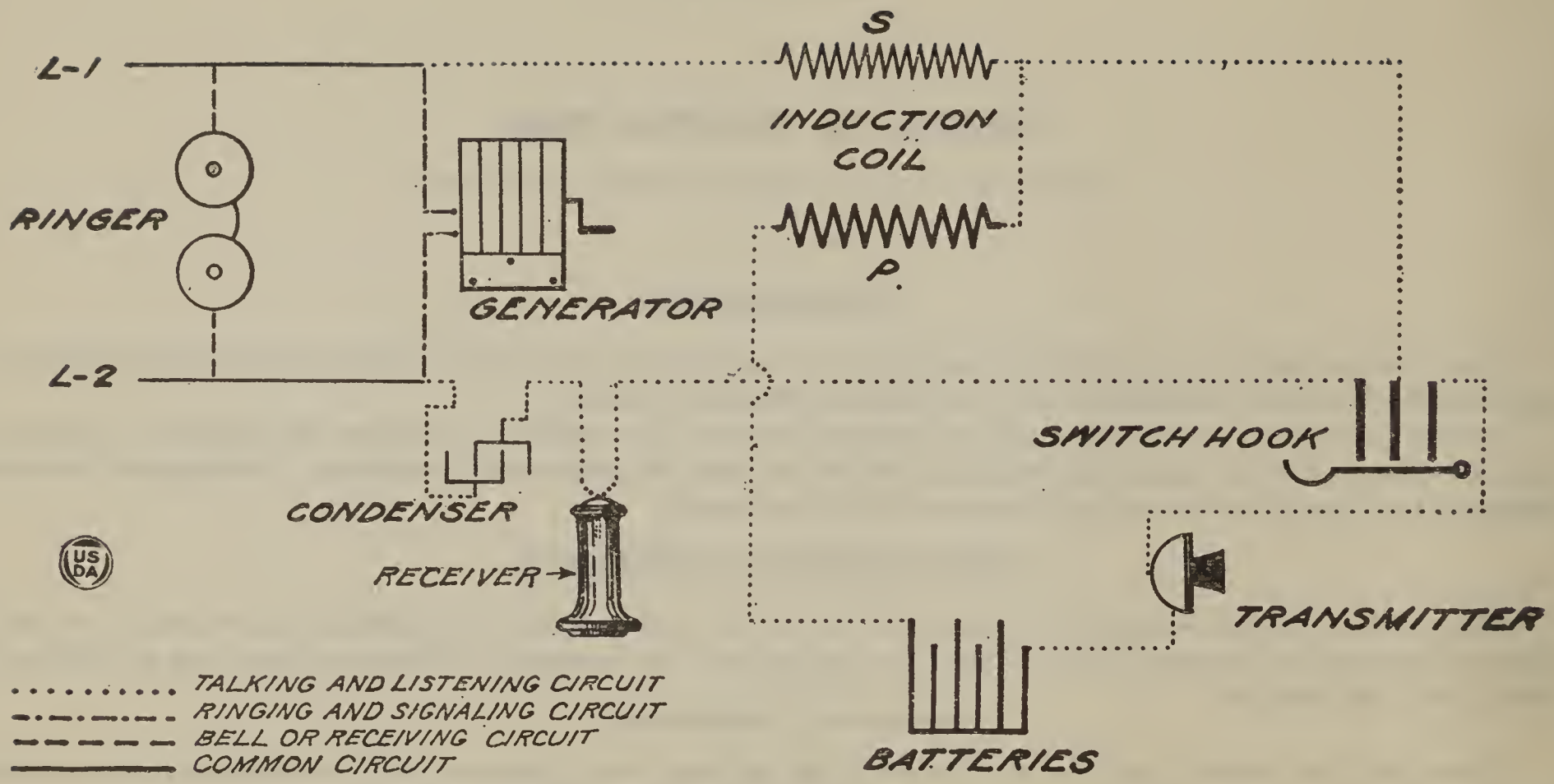

FIG. 1.—Circuit of a magneto telephone—schematic wiring 1317 S set.

These three circuits are:

(*a*) Talking and receiving circuit.
(*b*) Ringing or signaling circuit (to call other parties).
(*c*) Bell or receiving circuit (to receive calls from other parties).

(a) TALKING AND RECEIVING CIRCUIT.

The talking and receiving circuit consists of the following equipment:

1. Receiver.
2. Transmitter.
3. Induction coil.
4. Three cells of dry battery.
5. A switch hook.
6. Condenser.

(1) Receiver.

The function of the receiver is that of making it possible to hear others talking from distant points on a telephone line. It consists of a permanent magnet over one end of which is an electromagnet constructed of very small insulated copper wire, and it has a resistance of about 70 ohms. Over the end of this permanent magnet a diaphragm is placed in such a way that it does not quite touch the end of the magnet, there being a space between the diaphragm and the magnet of about the thickness of a piece of paper.

(2) Transmitter.

The transmitter is used solely for the transmission of speech to a distant point. The transmitter contains a diaphragm of similar construction to that used in the receiver. Fastened to the center of this is a little cup full of carbon granules. Both of the electrodes in the cup are insulated from each other by means of a piece of mica. A transmitter alone will not transmit voice currents without the aid of an electric battery. Better transmission results are obtained by the use of an induction coil in the transmitter circuit. (See fig. 1 for circuit wiring of a standard telephone instrument.)

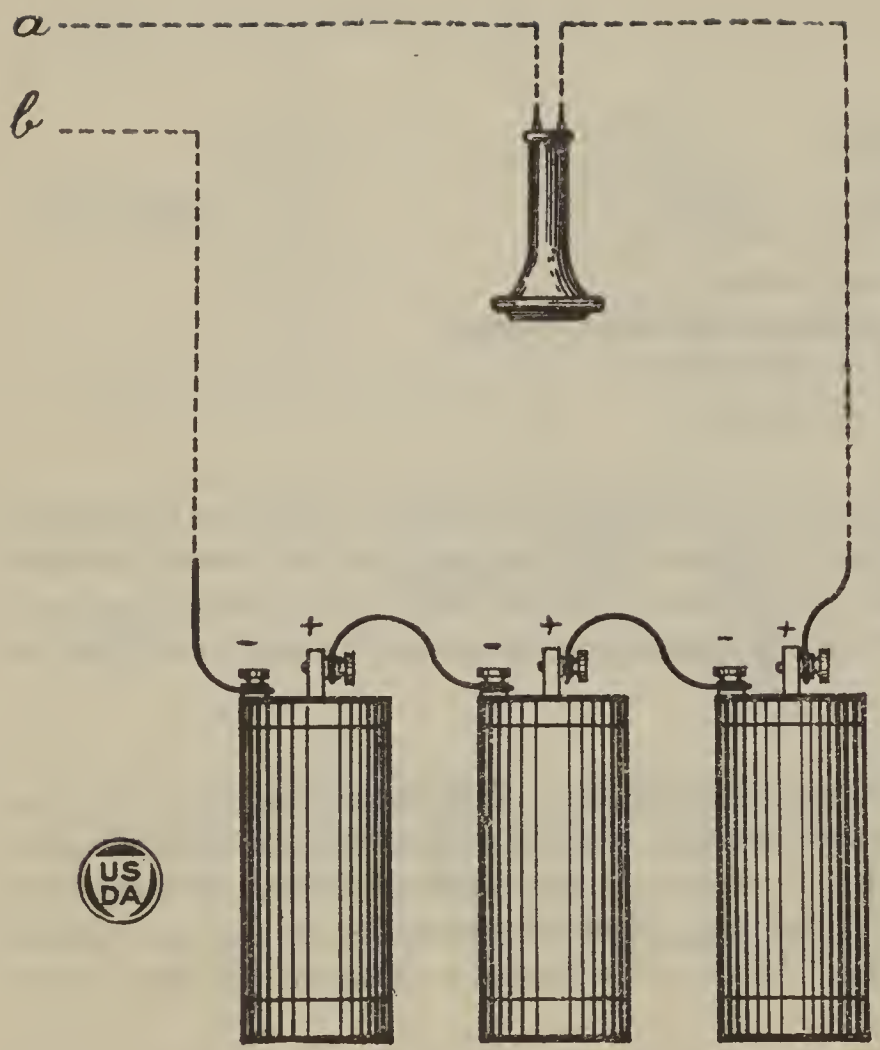

FIG. 2.—Receiving test and method of connecting dry batteries.

(3) Induction Coil.

The induction coil mentioned above is used primarily as an amplifier to improve the talking quality emanating from the transmitter and make it possible to talk greater distances than would be possible without it. The induction coil is constructed of a soft iron core around which several layers of small insulated copper wire have been wound. This is known as the primary winding. Over this primary winding several more layers of insulated copper wire are placed, there being no connection between this second winding and the primary winding. This is known as the secondary winding. The wire in the primary winding is usually a little larger than the wire used in the secondary winding. The two ends of the primary winding, however, are fixed on two terminals (punchings), as are also the two ends of the secondary winding, and are marked *p* for primary and *s* for secondary.

(4) Dry Battery.

The dry batteries are necessary for the operation of the transmitter, but they perform no other function in the telephone set. As will be shown later, they are not used for ringing the telephone bell or for ringing other telephone bells on the line. (Fig. 2 will show the method of con-

necting up three cells of dry battery. It is always advisable to use three cells of battery on all instruments installed within the National Forest.)

(5) Switch Hook.

The switch hook contains three contacts, which are all separated when the receiver is hung up, but when the receiver is lifted off the switch hook these three contacts come together. The purpose of this switch hook may be understood by reference to Figure 1. It will be noted in this diagram that, when the switch hook contacts are open, the entire talking circuit is left open. This is very necessary, for without a switch hook the battery would soon run down and become worthless. Receivers, therefore, should never be left off the switch hook when they are not in use.

(6) Condenser.

The condenser used in a telephone set is made up of two strips of tinfoil insulated or separated from each other by means of a long strip of paraffin paper, which is known as the dielectric. An additional strip of thin paper is also put on either side; then the whole thing is rolled up and pressed into the metal container seen in the set. Each contact is attached to a sheet of tinfoil. A condenser is open to battery, but an alternating circuit will flow through it. Its purpose is to make it possible to ring other parties on the line even though the receiver at one station has been removed from the hook.

(b) and (c) RINGING AND SIGNALING CIRCUIT.

1. Generator.

All signaling is accomplished by means of a hand generator commonly known as a magneto. This magneto, when the handle is turned, generates an alternating current within itself. The current goes out on the line and rings any bells properly adjusted to it. There are various types and styles of magnetos, some having from two to five permanent horseshoe magnets and some having even more. The generator having five magnets is the standard type used

within the National Forests. It should be understood that in general the more magnets a generator has the more powerful it becomes. Between these horseshoe magnets is a coil of insulated copper wire wound around an iron base commonly called an armature. The revolution of this armature between the poles of the permanent magnets generates the current. Its only function in a telephone set is that of calling other telephones on the line. (Fig. 3 shows the construction of a generator.)

2. Ringers.

Signals are received from other stations on the line by means of what is known as a polarized bell. This bell, or ringer, as it is called, consists of two electromagnets, over which is a permanent magnet and an armature with a clapper ball *h*, pivoted in the center so that it may strike either bell. (See fig. 4.) The resistance of the electromagnets varies in accordance with the use and the lines on which they are intended to be used. On all long and heavily loaded lines, ringers wound to a resistance of 2,500 ohms are preferable. This is divided into 1,250 ohms on each coil. (For the proper adjustment of a telephone ringer, see paragraph "Adjustment of Ringers," p. 7.)

TESTS, REPAIRS, AND ADJUSTMENTS (TELEPHONE).

There is nothing mysterious or difficult about the testing of a telephone. All parts of the set are accessible, and it is seldom that any trouble actually exists in the telephone set. When trouble does occur on one of the lines, careful tests should be made before a conclusion is reached that the trouble is in the telephone instrument itself. (See p. —.)

Provided the telephone instrument was properly adjusted when it was installed, about the only troubles found in a telephone set under ordinary conditions are the exhaustion of dry batteries, the breaking or wearing out of receiver or transmitter cords, or the loosening of the connections where the line wires are fastened to the set. (Before making any tests on your telephone instrument, see section, "General Trouble—Instrument and Line.")

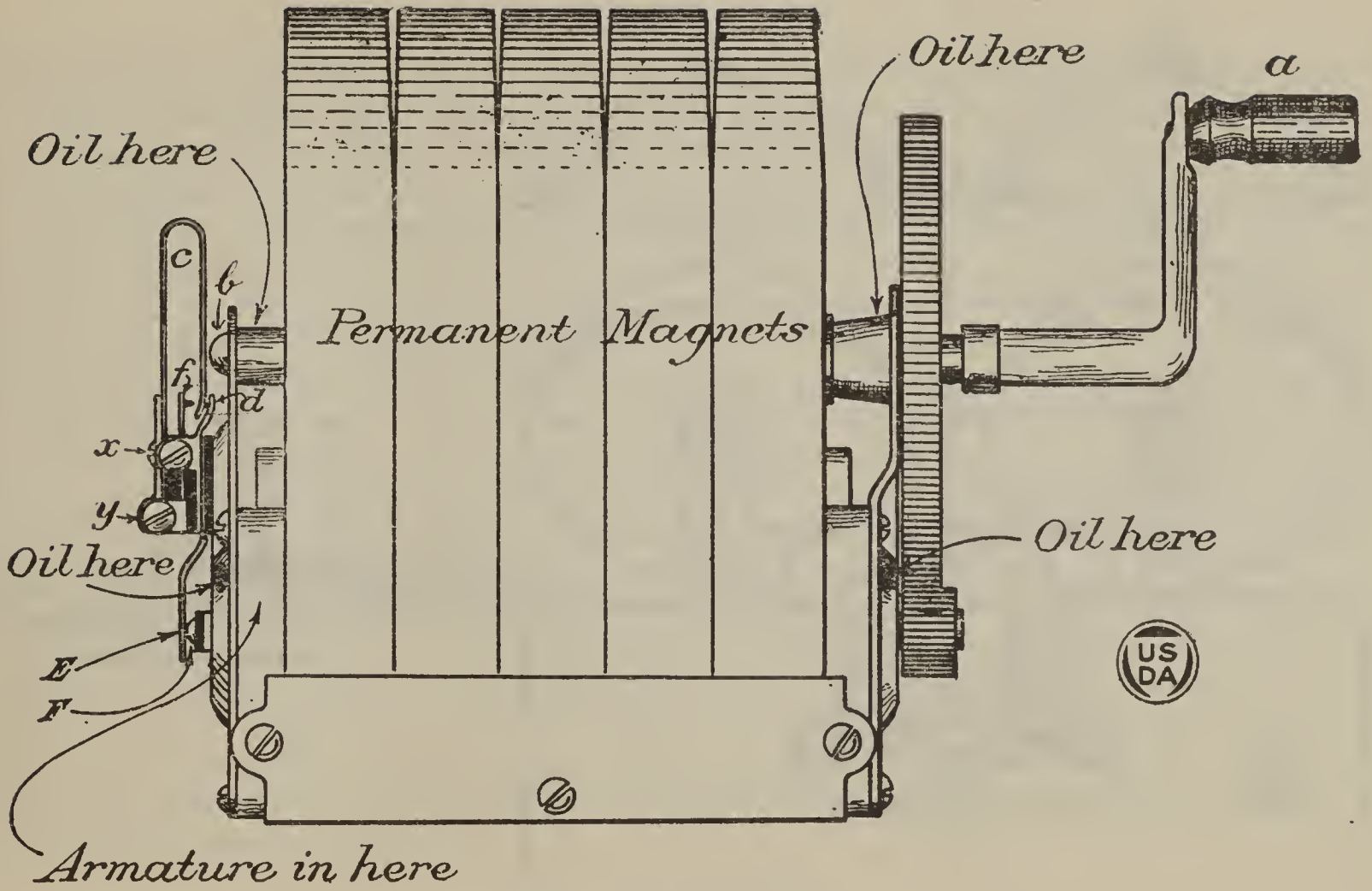

FIG. 3.—Type 48A generator.

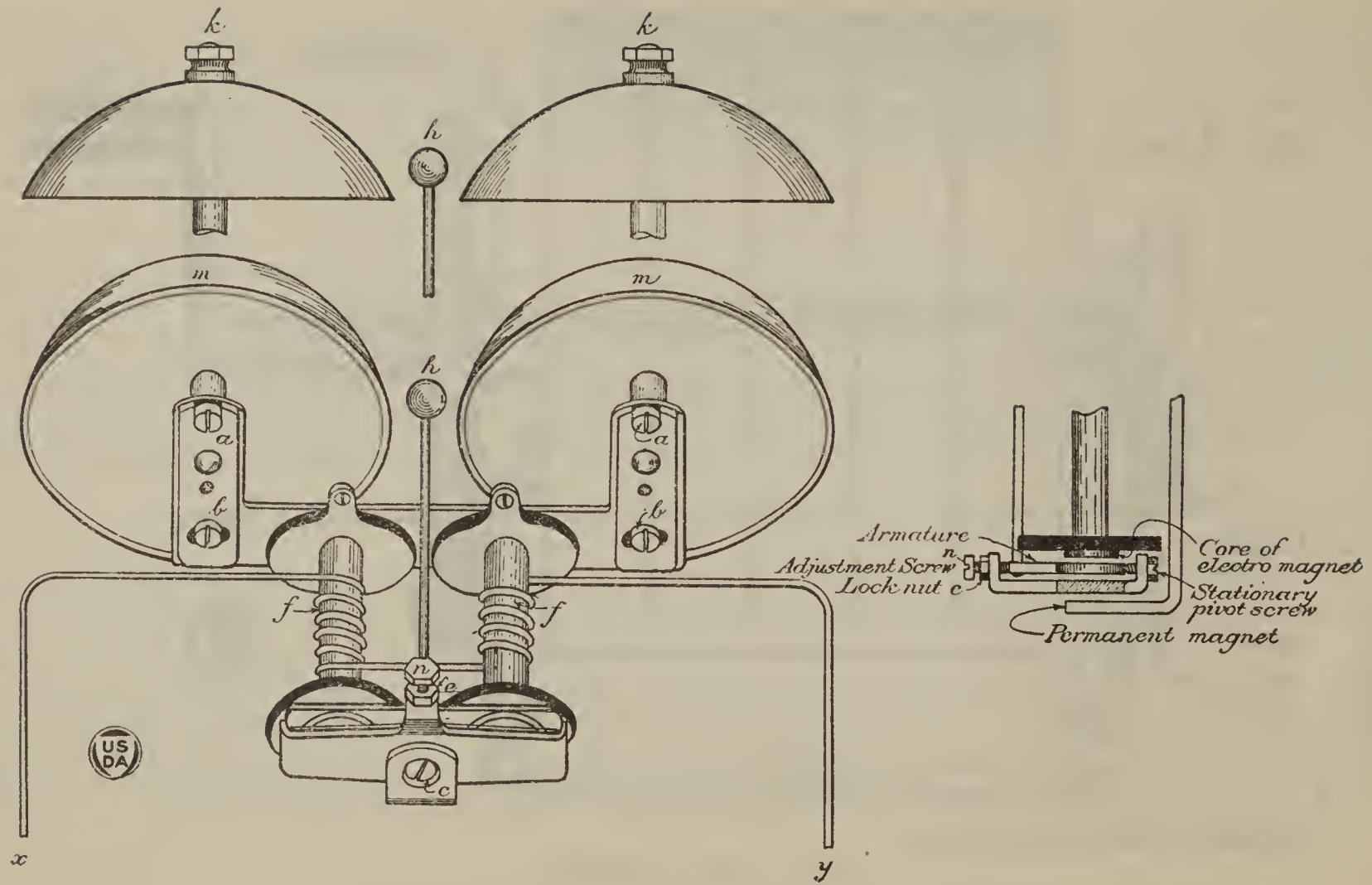

FIG. 4.—Showing construction of 38BG telephone ringer.

1. Generator.

In making all generator tests first be sure that the receiver is on the hook. Now disconnect wires *x* and *y*, as shown in Figure 3. Place the moistened fingers across the screw contracts *x* and *y* and turn the generator crank. If a stinging sensation or shock is felt in the fingers while the crank is being turned, this indicates that the generator is operating properly. If, on the other hand, the telephone generator turns hard, or if no stinging sensation or shock is felt, there is trouble in the generator. As a result of this test it will be found that the generator is either open or short-circuited. If open, the crank will turn easily; if short-circuited, the crank will turn hard. If the crank turns hard, the trouble in all probability is a short circuit in the rubber bushings separating the spring contacts. (*C–B–F–D*, fig. 3.) If such is the case, there will probably be an odor of burning rubber. In order to rectify this trouble it will be necessary to remove the entire spring assembly from the generator, take it apart, and locate the bushing that has become carbonized. When this bushing has been located, the carbonization should be scraped off carefully with a knife and the bushing and springs replaced. (Extreme care must be used when taking the springs apart in order that all parts may be replaced *exactly* as they were.) Carbonizing of the rubber bushings is caused by oil coming in contact with them. It will be necessary to replace the defective bushing with a new one. Before reassembling the spring contacts, all the bushings and springs should be wiped off carefully to remove any superfluous oil.

It sometimes happens that the permanent magnets on the generator become weak after long usage. This will be indicated by a reduction in the amount of current the generator gives. If the generator produces only a feeble current when the crank *a* is rapidly turned, it is a clear indication of weak magnets. If such is the case, either a new set of magnets is necessary, or a remagnetizing of the old magnets, or the replacement of the entire generator. Sometimes the generator is weak because some one has taken it apart and replaced a magnet incorrectly. Each magnet has a punch mark on it, and these punch marks should face the back of the generator. If the magnet is reversed, the strength of the generator will be greatly reduced.

The contact springs on the end of the generator serve automatically to connect the generator across the line and also serve to protect the generator from being burned out by lightning by means of what is known as a "shunt". The correct operation of these springs is as follows: When generator crank *a* is turned, rod *b* makes contact with spring *c*, breaking contact between *c* and *d* and making contact between *c* and *f*. (See fig. 3.) When the operation of crank *a* ceases, rod *b* breaks connection with spring *c;* spring *c* breaks connection with spring *f*, and spring *c* makes connection with spring *d*. This automatically disconnects the generator from the line and puts a short circuit (shunt) across the generator. This prevents lightning from coming into the generator and burning out the armature. If the crank turns easily, either the armature is open or one of the contact springs is dirty or bent and not functioning properly.

Generators need oiling only occasionally, probably not oftener than once every year or two. When this is done a drop of oil on the end of a straw should be placed in oil holes as marked in Figure 3. Under no circumstances should more than one small drop be used in each of these oil cups. All surplus oil around these oil cups should be wiped off carefully. A good grade of typewritter oil should be used for this purpose.

It is *very important* that rod *b* on the generator return to its position when generator crank *a* is standing normal; also that the springs *c*, *f*, and *d* should properly function, as shown in Figure 3. Any deviation from this operation will result in generator trouble. After completing all tests and repairs on the generator, replace the wires on binding posts *x* and *y*. See that spring *E* makes contact at all times with rod *F*.

2. Ringers.

Before testing the ringers be sure that the telephone receiver is on the switch hook, that the line wires from the protector to the telephone are disconnected from the binding posts L–1 and L–2, and that the generator is operating properly, as previously described. First moisten the tips of your fingers and place them across the two binding posts *x* and *y* (fig. 4) on the ringers and turn the crank. If current is felt, the wiring from the generator to the ringers is all right. If no current is felt, and the generator is operating properly, the wiring is open between the generator and the ringers.

The following adjustments (fig. 4) are necessary to secure the proper operation of a pair of ringers. The clapper ball *h* of the ringers, which is attached to the armature, should move freely. In most cases it should bave a movement of about one-sixteenth to one-eighth of an inch. The gongs *k* should be so set that the clapper ball just strikes each gong. The gongs are adjusted by loosening screw *a* and turning screw *b* to the right or left according to the way it is desired to move them. The adjustment of the armature to or from the magnets is accomplished by turning screw *c*. However, it is always desirable to adjust the armature as close to the magnets as possible, provided, of course, that the proper amount of sweep is obtained for the clapper ball. The armature is suspended in the center by means of two pivots. The back pivot is usually stationary while the front pivot is adjusted by means of a screw *n*. After loosening lock nut *e*, the armature should be so adjusted that there will be a little play at screw *n*. When the proper adjustment has been obtained, nut *e*, which is known as the lock nut, should be tightened so that it will be impossible for screw *n* to shake loose. The proper adjustment of screw *n* and lock nut *e* is *very important*. A word of caution is given here to be sure that adjustment screw *n* does not turn and thereby tighten the adjustment while tightening the lock nut *e*.

The electromagnets *f*, or ringer coils, as explained previously, contain a large number of layers of small insulated copper wire. The wire is wound around the ringer coils, as shown in Figure 4. The ends of this wire are indicated as *x* and *y*, and, if these ringers are not properly protected against lightning and other foreign currents, this fine wire may be burned in two. If this happens, the ringer coils will be found on test to be open and it will be impossible to obtain a ring on them until these ringer coils have been replaced with new ones. The receiver test (see text and fig. 2) may be used for determining which of the ringer coils is open. If the entire ringer should become loose from the door of the telephone set, it will be necessary to remove the gongs *m*, *m*, in order to tighten it.

It is very important in purchasing telephones to see that all ringers on any one line are of the same resistance. Otherwise the ringer or ringers of lower resistance will take most of the ringing current, and the remaining ringers of higher resistance will operate weakly or not at all. Figure 5, Diagram A, illustrates four telephone sets on the same line. As indicated by the arrows each ringer is receiving its proportionate amount of current because all ringers are of the same

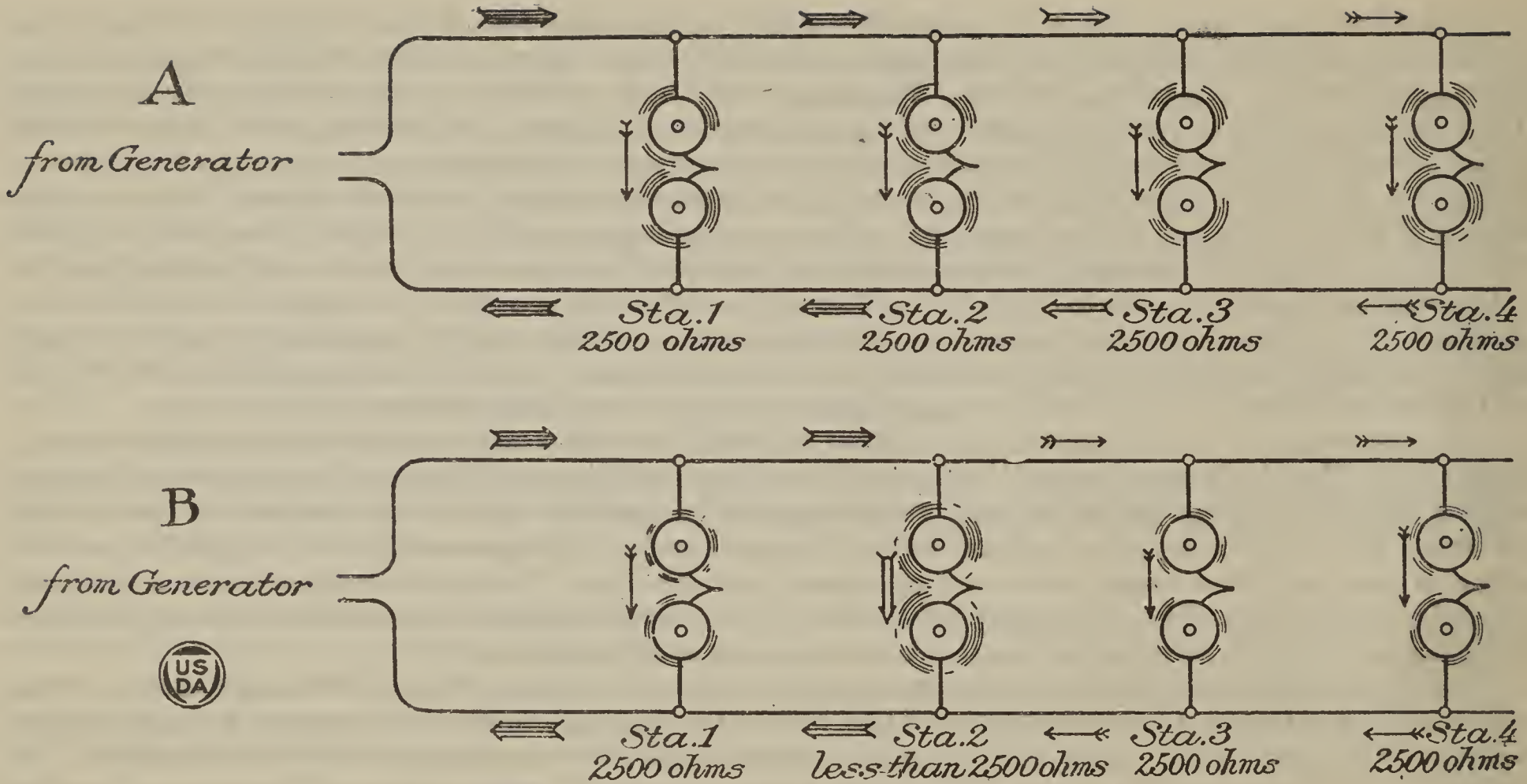

FIG. 5.—Effect when ringers on a line are not all of the same resistance.

resistance. Figure 5, Diagram B, shows how Station 2, which has less resistance than the other three ringers, receives more than its proportion of the ringing current. This will cause Ringers 1, 3, and 4 to operate either weakly or not at all.

3. Switch Hook.

As the switch hook receives continual hard usage, it needs occasional inspection. The ordinary switch hook is subject to the following troubles: The contact springs get out of adjustment, the main spring used for raising the hook lever becomes weakened from constant usage, and poor electrical contact between the springs results. The only function of the switch hook is to connect the talking and listening circuit to the line when the receiver is removed from the hook preparatory to talking. When the receiver is thus removed the three springs should be in contact with each other. When the receiver is replaced all *three* of the contacts should be *open*.

4. Receiver.

Following are the troubles liable most frequently to affect the receiver: The diaphragm may become bent or dented in such a way that there is no longer a space between it and the permanent magnet. This may frequently be corrected by reversing the diaphragm; that is, taking the side of the diaphragm that is now next to the permanent magnet and placing it so that the opposite side is next to the permanent magnet. If that does not correct the difficulty, put in a new diaphragm. Sometimes dust and iron filings collect on the permanent magnet; these should be carefully wiped off. Due to dropping of the receiver or sudden jarring, the space between the permanent magnet and the diaphragm is sometimes increased or decreased. This will greatly lower its sensitiveness. Either the trouble should be corrected or a new receiver should be installed.

Sometimes the permanent magnets in the receiver become weak after long usage, and replacement is necessary. The electromagnet, explained previously, sometimes becomes opened as a result of being burned out by lightning or other outside electrical disturbances. When this happens a new receiver is necessary.

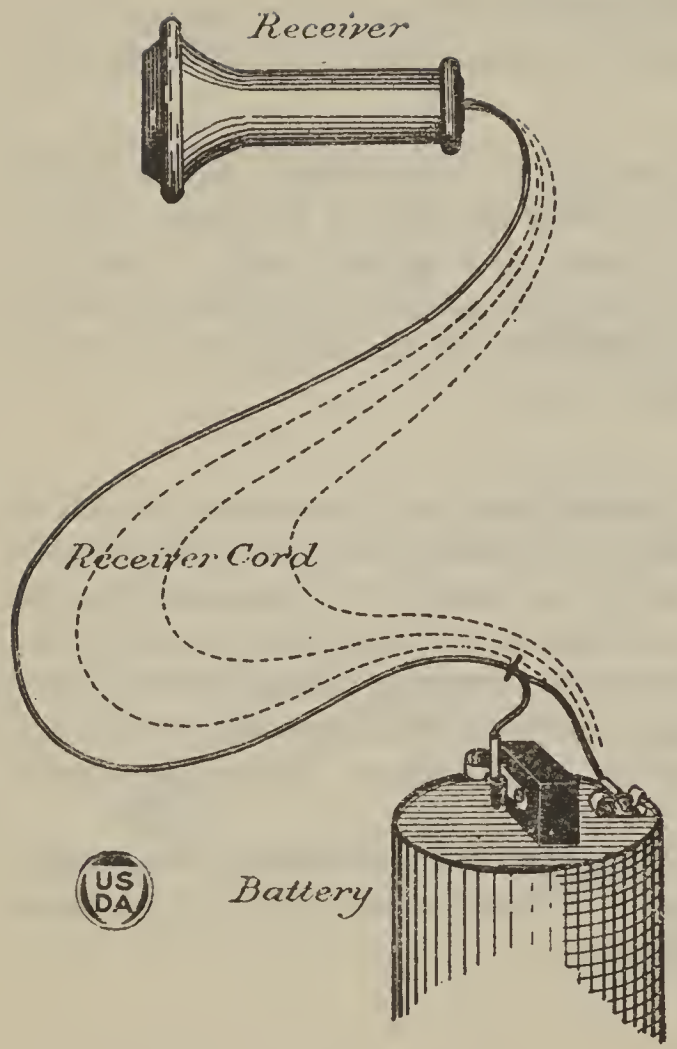

FIG. 6.—Receiver cord test.

(*a*) *Receiver test.*—A simple method of testing a receiver is shown in Figure 2. If *a* and *b* are touched together and no click is heard in the receiver, the receiver is open.

A receiver may be used for testing in conjunction with the battery, as shown in Figure 2. To locate broken wires in the ringer coils, induction coil, or any other electromagnet, simply touch wire *a* to one side of the wire of the coil to be tested and touch *b* to the other end of the wire of the coil to be tested. If a click is heard in the receiver, the wiring is all right. If no click is heard, the wiring in the coil that is being tested is open.

(*b*) *Receiver-cord test.*—The method of testing a receiver cord is shown in Figure 6. By connecting both contacts of the end of the receiver cord to the battery to the other two terminals in the receiver and by taking the hand and shaking the cord and bending it backward and forward it is very easy to locate a loose connection or break in the cord. If the receiver cord is in good shape no noise will be heard by listening in the receiver. If, on the other hand, the receiver cord is defective, a grating, grinding, or clicking noise will be heard, and a new receiver cord is necessary.

5. Transmitter.

The transmitter seldom gets in trouble. Its function and construction have already been explained. It sometimes happens, however, that some of the adjusting screws or parts of the transmitter become loose and fall out while in transit. Great care should be exercised to see that these screws

and parts are properly tightened and packed to insure its arriving at its destination without damage. If a transmitter is badly damaged, it is advisable to procure a new one. When a transmitter has stood in one position for a considerable length of time it sometimes happens that the carbon granules become lodged or packed together in such a way that they do not function as they should. A gentle shake may make the transmitter operate properly. Never violently jar the transmitter, and never take it apart, as adjustments on the transmitter should be made only by one having expert knowledge of its construction.

6. Dry Batteries.

Figure 2 illustrates the method of connecting dry batteries. (See solid lines showing connections.) All dry batteries should be replaced every 12 months and more often if necessary. It is preferable to renew dry batteries in the spring before the summer work commences. One or two fresh batteries should *never* be connected to an *old* one. All connections to the battery should be tight, and the wires used in making the connection should be properly cleaned before using. *Never under any conditions take off the paper covers* that come around the dry batteries. This paper cover forms the insulator of the zinc electrode in the battery. Batteries should be tested—preferably by a small ammeter battery tester—and the battery that shows a reading of less than 8 or 10 amperes should not be used. An emergency test to determine whether or not a dry battery is absolutely dead may be made by touching the tongue to both electrodes of the battery. If a slight acidulous or salty taste is noted, the battery is not absolutely exhausted, although it may be so nearly exhausted as to be incapable of giving good transmission. In extreme emergencies exhausted dry batteries may sometimes be temporarily revived so that they will give sufficient current to send an important message by driving holes with a nail through the zinc shell near the top and allowing a small quantity of water to soak through them. When a replacement of batteries is necessary always replace all three cells at the same time. When these are installed they should be *dated* and *initialed* by the man installing them. Weak or exhausted batteries are usually the cause of one's not being able to make others hear him talk. A transmitter will not talk up when poor or weak batteries are used. In order to get efficient transmission there must be a great deal of energy (good batteries) behind it. Sometimes one

or two of the three batteries become exhausted. If one battery still has a little life, use it, throw out the poor ones, and order three new batteries at once. One or two bad cells will kill a good one.

7. Induction Coil Tests.

It is very seldom that anything happens to an induction coil. The function and construction of this coil were explained previously. If, however, either of the windings in the induction coil becomes open from any cause, it will be impossible to talk over the transmitter. Do not infer from this that whenever the transmitter does not talk the trouble is in the induction coil. (See paragraph on transmitter.) Should it be found by using the receiver test for testing out an induction coil that either of the coils is open, a new induction coil will be necessary. When the test is made, however, all wires should be disconnected from the induction coil. It is possible to get a conversationt through even if the induction coil is burned out by putting a wire across the two primary contacts and another across the two secondary contacts. This should be done only in cases of emergency until a new coil can be put in. (See fig. 1.)

8. Condenser.

Each telephone used should be equipped with a condenser in the receiver circuit. Figure 7 illustrates the necessity of a condenser in the receiver circuit. Figure 7, Diagram A, illustrates a receiver which has been taken off the hook by a party at Station 3. It should be noted that the arrows which show the current coming from the generator show all the current going through the receiver at Station 3 and none of it going beyond this point. Figure 7, Diagram B, shows the condenser in the receiver circuit at Station 3. The party has taken the receiver off the hook, as in the other case, but because of the presence of this condenser it is possible to ring past this station regardless of the fact that this receiver is off the hook. This clearly shows the extreme necessity of using a condenser in the telephone sets. The condenser should have a capacity of 1 M. F. (microfarad). It is possible to equip any of the telephones now in use with condensers, if desired. Instructions for doing this work will be found on the diagram in the telephone set. (See fig. 1 for location of condenser in the telephone circuit.)

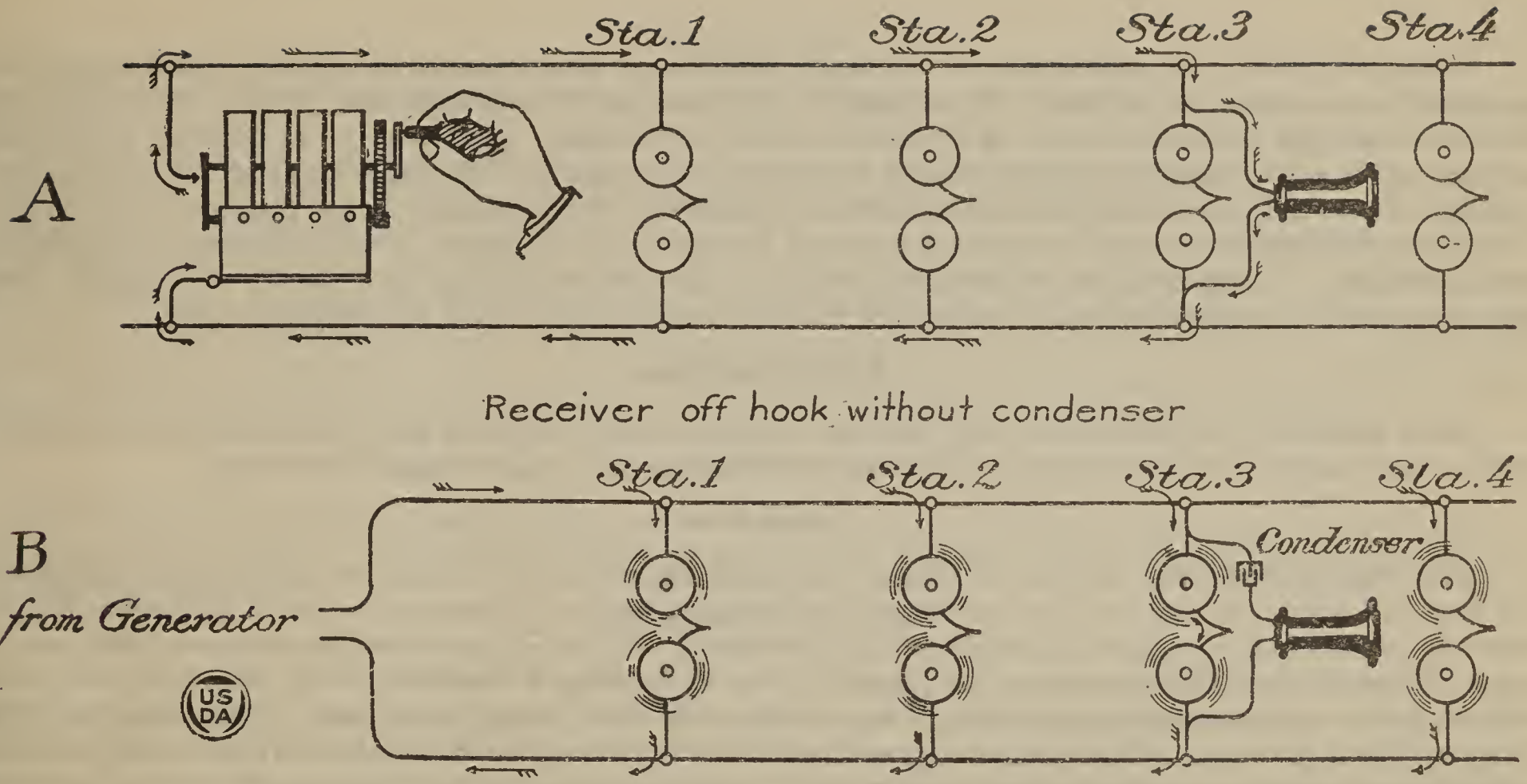

FIG. 7.—Use of condenser in receiver circuit.

Condenser trouble very seldom occurs. However, lightning or some other severe electrical disturbance may puncture or short-circuit a condenser. Even though a condenser may be short-circuited, it will not interfere with the operation of the telephone (except as to the function of the condenser noted above). If, however, a condenser is open, it will not be possible to talk or receive a message even though you can ring others and they can ring you. (See fig. 1.) If a condenser is thought to be open, put a wire across the two terminals of it, and then see if you can talk.

Condensers seldom cause trouble in the instrument, but when one is damaged it will be necessary to replace it with a new one. Damaged condensers, however, should not be destroyed, as they may usually be repaired. They should be held in the office until some one familiar with this work is able to make the necessary repairs.

LINE TROUBLE.

Before classifying the troubles that may occur on telephone lines it is well to give certain information, together with an explanation of the terms used, in order that the directions may be more readily understood.

LINE OPEN.

A line may be open at any one of several places—at a break somewhere out on the poles or trees, at the point where the drop wire breaks off to go into the building, on the leading-in wire to the protector, at one of the fuses in the protector, or on the inside wire from the protector to the instrument. In case of a grounded line the ground wire may be open. There may be a loose connection in the ground wire or an unsoldered connection on the ground rod; the ground rod may not be of the standard type; or the rod may be driven in sandy, rocky, or dry soil. If the ground rod is too short, trouble due to open or high resistance ground will result. Frozen ground as well as dry soil is almost a nonconductor, and a short rod will fail to make the ground. Sometimes a loose or poor connection in the line may show up as an open.

SHORT CIRCUIT.

In the case of a metallic line both the line wires on the poles may become twisted together, a foreign wire may be lying across both the line wires, or the line wires may be lying on this foreign wire. This foreign wire may be a telephone line or a guy wire. Pieces of baling wire or other waste wire may become entangled with both wires and form a short circuit. The leading-in wire may become short-circuited regardless of the fact that it is insulated as a result of the wearing out of the insulation or because of mechanical injury of some sort. The sooting up of protector blocks in the lightning protector may cause a short circuit. Also the wires leading from the protector to the instrument may become short circuited either from mechanical injury or from a staple or tack being driven through both wires. In the case of a grounded line a short circuit may result from any foreign ground or foreign wire which runs to ground touching the line wire or any of the drop wires. In the case of grounded lines the leading-in wire and the protector blocks or the inside wire will cause a short-circuited line under the same conditions as in the case of metallic line.

CUT-OFF.

This may be and usually is caused by either a poor connection in any part of the line or instrument wiring or a loose, unsoldered connection. A swinging short circuit may also cause a cut-off. In the case of a grounded line a swing to ground will cause it.

INTERMITTENT GROUND.

An intermittent ground on a metallic line will be noticed by the coming and going of induction, although a loose connection on one side of the metallic line will also cause induction on it. With a swinging ground, however, the transmission on the metallic line will remain about the same; but in the case of a loose connection causing noises the transmission will be very much poorer when the noise is on the line than when the line is quiet. A swinging ground on a grounded line will be the same as a swinging short circuit.

SUMMARY.

Briefly, line troubles may be any one or more of the following:

1. *An open in the line.*—Caused by the breaking of a line wire, drop wire, leading-in wire, or the blowing of a fuse.

2. *A short circuit.*—Caused by two line wires of a metallic circuit coming in contact or being connected by a metallic object.

3. *A ground.*—Caused by either line wire of a metallic circuit or the single wire of a grounded circuit touching the ground or conducting material connected with the ground.

4. *A cross.*—Caused by the line coming in contact with wires of another line.

5. *Resistance trouble.*—Caused by loose, rusted, or corroded connections in the line wire, lightning arrester, fuse, or by poorly made or dried-out ground connections.

METHODS OF TESTING AND LOCATING LINE TROUBLE.

There are several methods of locating trouble on telephone lines, some of which, however, are too complicated for use except by the more experienced telephone man.

WHEATSTONE BRIDGE.

Probably the most effective method of locating trouble is by means of the Wheatstone bridge. All line wires, regardless of size or quality, have a resistance of a certain number of ohms per mile. With the Wheatstone bridge, an instrument used to measure a line in ohms, it is possible to measure to a high degree of accuracy up to the point where the trouble is. This resistance is then calculated into miles and feet and the location of the trouble definitely established. The Wheatstone bridge, however, is an instrument that is quite complicated in its operation and as a

general rule it could not be handled with any degree of accuracy in ordinary Forest Service work. It is, therefore, recommended only if the man using it is an expert and has a thorough knowledge of its functions and capabilities.

THE VOLTMETER TEST.

The voltmeter test is a very simple and fairly accurate method of locating troubles on a telephone line. In fact, if one becomes thoroughly familiar with its uses and limitations, a very high degree of accuracy may be obtained. It is thoroughly practical to install one of these voltmeter-test stations in certain localities from which four or five lines radiate. The best results from the use of it on the National Forests have been obtained by putting grounds and short circuits in different localities on different lines and taking tests under different weather conditions—dry weather, wet weather, and average weather.

It is necessary that these three tests be taken in order that the best results may be accomplished. Before installing any of this equipment, however, the matter should be taken up with the district forester for investigation.

LINE TESTS WITH COMMON TELEPHONE INSTRUMENT.

The greater the load on a telephone line the harder the generator turns, and, conversely, the fewer the telephones and the lighter the load the more easily the generator turns. When short circuits on a line occur the generator will turn very hard, varying inversely with the distance of the trouble from the telephone set on which the test is being made. That is, the farther away the trouble the more easily the generator will turn; and, even though the trouble is at a considerable distance, it will turn harder than when the line is in normal condition. When a short circuit on a grounded or metallic line, as the case may be, is very close to the instrument where the test is being made it will be found, when the generator is turned, the bells on the telephone will not ring. If, however, the short circuit or ground on the line side of a grounded line is some distance away, the bells will ring faintly. Even then, however, it will be found that the bells will ring considerably more loudly when the line is normal. When the generator turns very

easily, more easily than it does under normal conditions, it is a fairly sure sign that the line is open. This open may be at the switch, on the line itself, or in a fuse. It will be found that the generator will turn more easily when the open is close to the telephone than it will if the open is quite a distance out. Thus line capacity will have to be taken into consideration in attempting to locate the open.

GENERAL TROUBLE—INSTRUMENT AND LINE.

WHERE TO LOOK.

If the telephone set does not work properly, the trouble may be in the set, in the interior wiring of the building, at the lightning protector, in the ground connection, or out on the line. To locate the cause, look for the description of the trouble in the headings listed below and follow the directions given.

When tests are being made to locate trouble the following procedure should be followed as closely as conditions will permit. *Never*, under *any circumstances*, start in to clear trouble by *tearing your telephone* set to pieces before a proper location has been obtained.

In making the test, the first thing to do is to disconnect the instrument at the lightning protector; then test out the telephone set and inside wiring. If no trouble is found there, reconnect the inside wires on the protector, and disconnect the leading-in wires from the protector. (See fig. 8.) Now make another test of the telephone set. If trouble is now found, it will be in the protector. If no trouble is found, it will have been proved that the inside wiring and protector are in proper condition. Now disconnect the drop wire from the main line and make another test. This will prove whether or not the trouble is between the main line and the telephone. This method of testing is by what is known as the process of elimination. These preliminary tests will prove whether or not your telephone installation from the main line to your station is all right. If the trouble is out on the line, it may be in either direction from the station. In order to tell definitely which way it is from the station, the line *must be opened*. Then,

with a test set, test each way on the line to determine in which direction the trouble is. If no test set is available, after the main line wire has been opened, attach the drop wire to one side temporarily and make a test from the telephone set in the station; then change the drop wire over to the other side of the opened line and test. This will give definite information as to which way the trouble lies from the station.

If the telephone and equipment at the station have been properly installed and adjusted, there is very little chance for trouble in that instrument, although there may be trouble in the lightning protector.

1. YOUR TELEPHONE BELL DOES NOT RING OR RINGS FAINTLY WHEN OTHERS CALL.

(*a*) Broken line wire, broken drop wire, or broken leading-in wire.

(*b*) Fuse open at protector or on outside of building.

(*c*) Short-circuited line, lightning protector blocks sooted up, or mica left out of protector

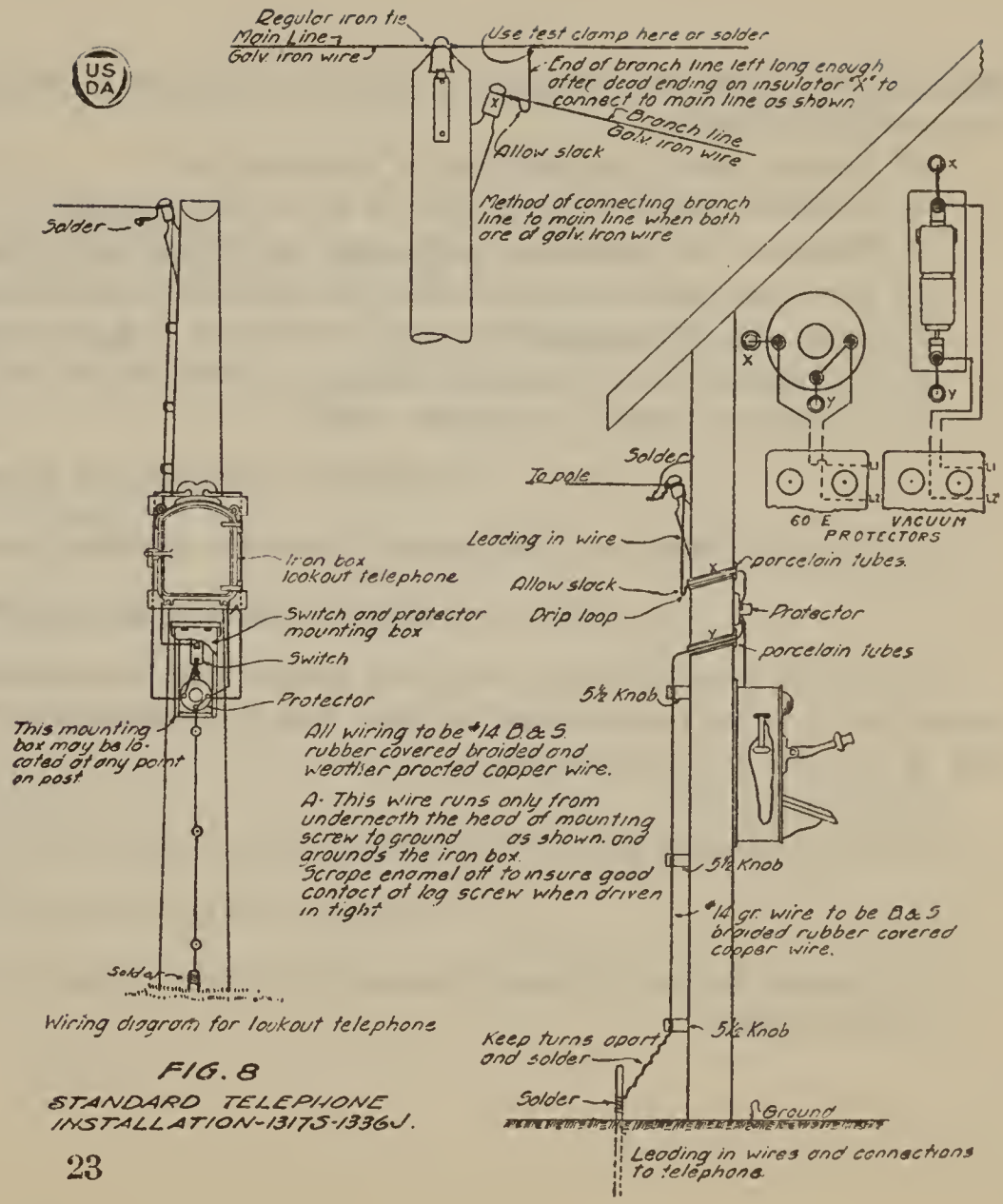

FIG. 8
STANDARD TELEPHONE INSTALLATION-13175-1336J.

blocks from a previous cleaning. In case of grounded line, line wire grounded, either out on main line or in lightning protector blocks.

(*d*) Broken wire or connection in telephone set.

(*e*) Defective ringer—either open or out of adjustment.

(*f*) Ringer of low resistance connected somewhere on telephone line. (See fig. 5.)

(*g*) Some one has left receiver off hook at point where there is no condenser in receiver circuit. (See fig. 7.)

(*h*) Short circuit in generator at your own set or in some other set on the line.

(*i*) Overloaded line—too many telephone instruments on line.

(*j*) Permanent magnet on ringers weak.

2. BELLS RING FREQUENTLY WITHOUT APPARENT CAUSE.

(*a*) Swinging cross with telegraph, telephone, or other line.

3. BELLS AT SWITCHING STATION ALL RING WHEN CALLING ON ONLY ONE LINE.

If you call on one line at a switching station, and the extension bells ring on other lines extending out of the same station, even when the switches are open and no cross between the two lines exists, the trouble may be traceable to one or the other of two causes.

(*a*) Poor ground.

(*b*) Too high resistance of wire leading from ground, due to wire being too small.

4. YOU CAN NOT RING BELLS OF OTHER TELEPHONES.

(*a*) Broken line wire, broken drop wire, or broken leading-in wire.

(*b*) Fuse open.

(*c*) Short-circuited line (in case of metallic) or ground on line wire (in case of a grounded line) either out on line or in protector blocks at one of the instruments.

(*d*) Broken wire or connection in telephone set.

(*e*) Defective ringer or open ringer at station being called.

(*f*) Ringer of low resistance connected somewhere to telephone line. (See fig. 5.)

(*g*) Bell out of adjustment at station called.

(*h*) Permanent magnet weak on ringers at station called.

(*i*) Overloaded wire.

(*j*) Defective generator.

(*k*) Permanent magnets on generator weak.

(*l*) One of the permanent magnets on generator reversed.

(*m*) Poor ground.

5. YOU CAN NOT MAKE OTHERS HEAR YOU TALK.

(*a*) Dry batteries at your telephone weak.

(*b*) Dry batteries improperly connected.

(*c*) One defective dry battery will sometimes greatly lower the effectiveness of two good cells.

(*d*) Switch hook out of adjustment or the contacts poor.

(*e*) Connections to transmitter defective.

(*f*) Your transmitter packed. (Shake it up a little.)

(*g*) Receiver open.

(*h*) Receiver cord open.

(*i*) Induction coil open.

(*f*) Condenser open, or connection to condenser open.
(*k*) Transmitter cord open.
(*l*) Open battery connection.

6. YOU CAN NOT HEAR OTHERS TALK.

(*a*) Defective or dirty receiver.
(*b*) Receiver open or short-circuited.
(*c*) Receiver cord open or short-circuited.
(*d*) Receiver diaphragm bent.
(*e*) Switch hook out of adjustment.
(*f*) The telephone out of order, of the party you are trying to hear.
(*g*) Receiver magnets weak.
(*h*) Condenser open.
(*i*) Induction coil open.

7. YOUR CONVERSATION IS INTERRUPTED SO THAT AT TIMES YOU ONLY HEAR PARTS OF WORDS OR SENTENCES.

(*a*) Loose connection somewhere on the line. If line is grounded one, loose connection on ground wire.
(*b*) Line wires swinging together in the case of a metallic line, or line wire swinging to ground in the case of a grounded one.
(*c*) Line wire swinging to lightning rod on poles or to some other foreign wire.
(*d*) Receiver cord partly broken or short-circuited.
(*e*) Loose connection on batteries or at some binding post on protector or instrument.

(*f*) Loose connection between leading-in wire and drop wire, due to these wires being unsoldered.

(*g*) Unsoldered connection at ground rod.

8. THE STATIONS AT TERMINALS OF THE LINE HAVE INCREASED DIFFICULTY IN RINGING OR HEARING EACH OTHER.

(*a*) Too many stations on line.

(*b*) Too long a line for the size of the wire used.

(*c*) Poor ground in case of a grounded line.

(*d*) Corroded splices or poor joints in line.

(*e*) Any or all of these troubles may be combined with excess leakage because of the wire coming in contact with trees, poles, or foliage.

(*f*) If, after correcting all the above causes, trouble still exists, either the number of stations should be reduced, or the line should be rebuilt, and heavier wire of lower resistance should be used, or the line should be cut in two at some point, and a switch for relaying purposes should be established.

9. GENERATOR TURNS HARD.

(*a*) If it is a grounded line, line wire grounded.

(*b*) Ground in protector blocks at any station on line. (If ground is in protector or within 2 miles of the telephone where the generator turns hard, the bell at this telephone will usually not ring when the generator is turned.)

(*c*) If it is a metallic line, both wires crossed (short circuit).

(*d*) Protector blocks on each side of the line shorted together by lightning. This might be at two different stations.

(*e*) Rubber bushings on generator carbonized because of an excessive amount of oil.

(*f*) Mechanical trouble:

(1) Generator armature faces may be touching the pole pieces.

(2) Generator dry and needs oiling.

TESTING A STATION GROUND.

A simple method is here given of testing the ground of any intermediate telephone station. The test can not, however, be made for either a terminal or a lateral station, but is applicable only to stations on the main line. To test the ground, call up two parties—A and B—one on either side of the station, and ask them to talk to each other. The party who desires his ground tested may be known as X. While these parties are talking, X will attach the ground directly to the line. (This test can be made only on a grounded line.) If, after putting this ground on the line, A and B are still able to hold a good conversation, the ground at X is poor. If, when X puts this ground on the main line, it is practically impossible for A and B to hold a successful conversation, the ground at X should be considered good.

STANDARDS OF MAINTENANCE.

The following standards of maintenance shall be closely followed at all times:

(a) INSTRUMENTS.

1. All installations of wall or iron telephones should be in accordance with the standard specifications governing this work. (See fig. 8.)

2. All connections at telephone stations should be properly soldered.

3. All batteries should be renewed every spring and dated and initialed at the time they are installed.

4. When any repairs are made all connections in the instrument must be resoldered, and all connections at screw binding posts and batteries must be tight.

5. Only the standard grade of wire must be used in repairing all installations.

6. All fuses that have been burned out should be replaced with good ones.

7. Ringers must be kept in proper adjustment and generators must be kept working properly.

8. All grounds at telephones must be installed properly. The ground rods used must be *standard* in *every* particular and must be placed in accordance with standard instructions.

9. The lightning protector blocks should be kept clean at all times. After each electrical storm these blocks should be removed, and any soot or burned places on them should be removed by means of a knife, or a piece of fine sandpaper. Do not use paper or any other substitute for the mica. The mica should then be replaced, and the protector blocks put back in their proper place. This is very necessary where the old-style open-space, cut-out protectors are used. It will not be necessary to clean any of the new-type vacuum lightning protectors.

10. A code-ringing card, corrected currently, should be hung up at the side of each telephone.

(b) POLE LINES.

1. If any poles have been so weakened through decay that there is danger of their breaking off, they should either be reset or stubbed, or new poles should be substituted for them.

2. All anchor and guy wires should be kept tight and in condition to perform their functions.

3. Anchor guards should be attached to and maintained in connection with guy wires where the latter are used along wagon roads and trails.

4. All wire on pole lines should be kept tight, only sufficient slack being allowed for expansion and contraction, except in such places and under such conditions as are specified in the Telephone Manual where pole lines are used in conjunction with tree lines.

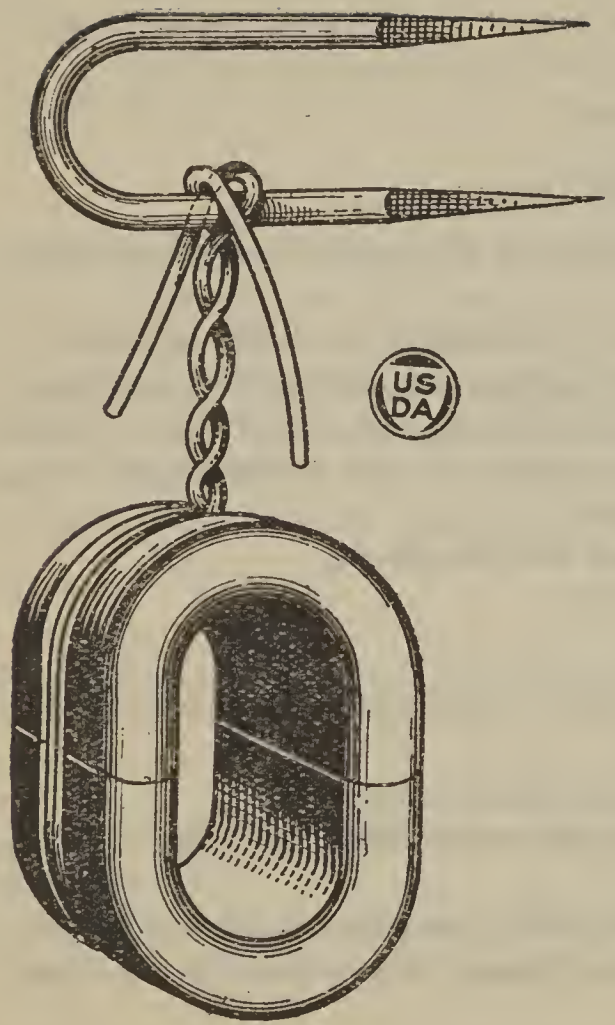

FIG. 9.—Method of attaching split tree insulator.

5. All broken brackets and insulators should be replaced as soon as possible.

6. Line wires should be kept properly tied to each insulator.

7. Splices should be made properly, and, if any were made incorrectly or have become rusted, they should be cut out and new connections should be made.

8. Corner poles should be pulled up so that the rake of the pole is away from the pull of the line.

9. Brackets on corner poles should be placed on the proper side of the pole, so that the strain of the line wire may be against the pole and the bracket may not be pulled off the pole.

10. Lightning rods on poles should be properly stapled.

(c) TREE LINES.

1. All spans should be properly equalized.

2. The line wire should be attached to the tree at a proper height, which is 15 to 18 feet above the ground.

3. All replacements of split tree insulators should be attached to the tree, the pull-away tie method, as shown in Figure 9 in this manual, being used. In fastening this tie a 3-inch staple should be used for thin-barked trees and a 3½ or 4 inch staple for thick-barked trees. No. 12 wire only should be used in making this tie.

4. The wire should be so attached to the tree that the pull is away from the tree and not against it.

5. All broken split tree insulators should be *replaced as soon as possible.*

6. In replacing split tree insulators, use only the D–1 oval brown type. (See fig. 9.)

7. All brush and limbs that touch the telephone line should be removed. A clearance of about 4 feet should be maintained between the line and any brush or limbs.

8. Splices in tree lines should be handled in the same way as in pole lines.

CARE OF ALL TELEPHONE INSTRUMENTS, BOTH WALL AND PORTABLE SETS.

Treat any telephone as you would your watch or a Forest Service compass. All instruments are more or less delicate and contain intricate mechanism. They should not be handled roughly under any circumstances. Never drop a wall or portable telephone on the ground, as this rough handling is almost certain to throw it out of adjustment. Never tamper with a wall or portable telephone if it is working satisfactorily. All reasonable care should be used in the placing of a wall telephone so that it can be kept *absolutely dry at all times.* The same care is necessary for a portable telephone. If after a thorough examination you are sure that your telephone is at fault, make the proper adjustment in it, as outlined previously; but be absolutely sure that the trouble is in the telephone set before you attempt to change the adjustment of it in any particular. If wall telephone instruments and portables are given the proper care, they will render excellent service at all times. If, on the other hand, the sets are handled in a rough manner and thrown around discriminately, only fair or poor results will be obtained.

BATTERIES USED IN PORTABLE TELEPHONES.

No. 1375A set, No. 703.—Everready Tungsten (or equal).

No. 1004A set (Adams portable), No. 705.—Everready Tungsten (or equal).

ADJUSTMENT OF ADAMS PORTABLE TELEPHONE.

The Adams portable telephone set occasionally gets out of adjustment as a result of rough usage, and it is sometimes necessary for field men to readjust it before successful signaling can be accomplished. This portable set signals to what is known as a howler at a distance point by means of a high-frequency current. In Figure 10 the details of the parts that occasionally need adjustment are shown. The vibrating spring assembly operates the same as the clapper of an electric bell. This vibrator assembly is attracted by the pole piece, which is energized magnetically by an electric current passing through the induction coil. In making the adjustment the best results are obtained by securing as high a frequency as possible. When this is obtained, a sharp buzzing noise should be heard from the vibrator spring. To adjust this spring properly, the lock screw clamp should be first loosened. A screw driver should be used to turn the contact screw very slightly to the right or left while the signal button is being depressed. When the proper tone is secured, the lock screw should be tightened to prevent the contact spring from being jarred loose. It should be noted, however, that the tightening of the lock screw will change the adjustment between the contact screw and the vibrator spring. In order to avoid this, the contact screw should be left just a little looser than desired before the lock screw is turned up. After this adjustment is attempted the amount of play to be left can readily be determined. Do not, however, attempt to turn the *contact screw without loosening* the *lock screw*, as the contact screw is liable to be damaged. In order to secure the best results with the

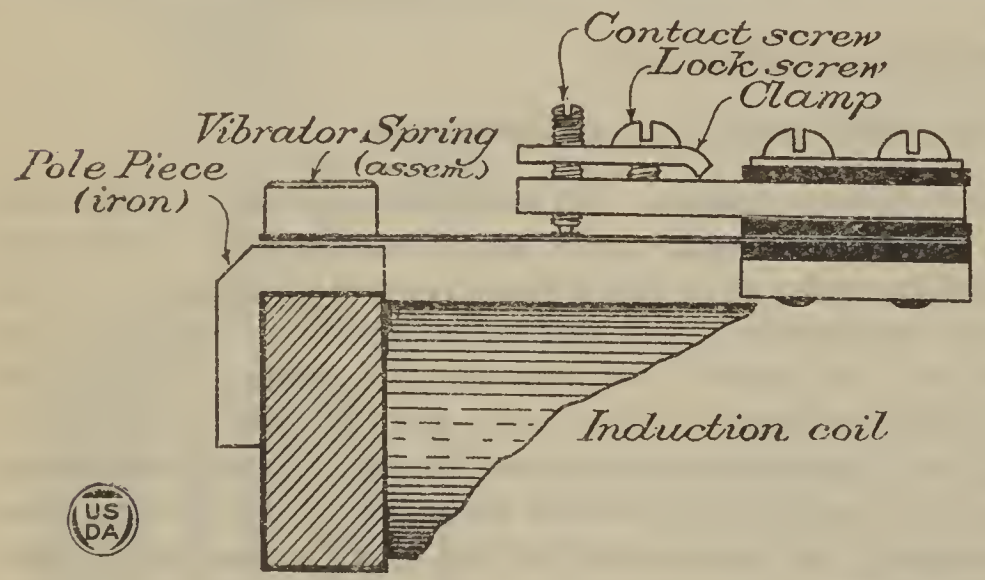

FIG. 10.—Vibrator spring assembly on an Adams portable telephone.

Adams portable telephone, an adjustment should be maintained which will secure the highest frequency possible, as the higher the frequency the farther it will be possible to signal. Before any change is made in adjustment *be sure* to have a *good* battery. (Dry batteries should *always be removed* from all portable telephones at the end of the field season.)

HOWLER.

The Adams portable test set can only be used to signal to what is known as a howler. The howler is a high-resistance receiver with a small megaphone attached. Instead of having a permanent adjustment, as in a telephone receiver, the diaphragm is capable of being moved close to or a distance away from the permanent magnets. The electromagnet coils in a howler are wound to a resistance of 1,000 ohms. Therefore, a howler should never be cut onto a telephone line direct, as the ringing efficiency on the telephone line will be greatly impaired. A condenser should always be cut in series with the howler. Use only a 1-microfarad (Type 21W) condenser for this purpose. Never under any conditions use any other condenser that has a greater or less capacity. Figure 11 shows the proper method of connecting a howler and a 21W condenser with either a 60E lightning protector or a vacuum protector.

ADJUSTMENT TO HOWLER.

Great care should be used when adjusting a howler to obtain the loudest tones possible. On the old type it is necessary during adjustment to tighten up the lock ring nut so that the diaphragm, which is attached to the top ring, can not move closer to or away from the magnets. On the new type the diaphragm is automatically locked during adjustment.

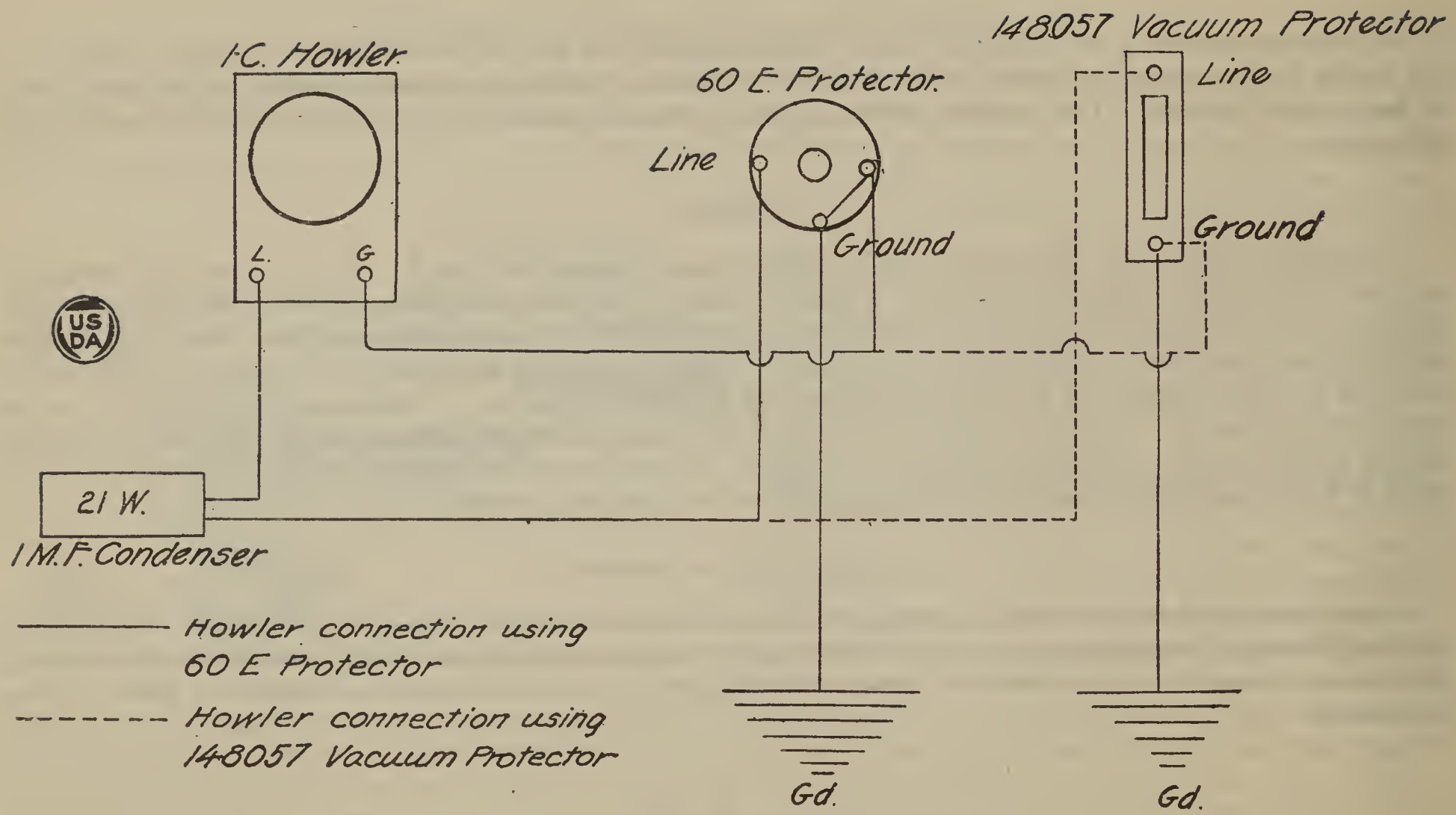

FIG. 11.—Method of installing howler and connections.

HOWLER TROUBLE.

Lightning and other high-tension currents burn out a howler and the electromagnet coils become open. The tests for locating trouble on a telephone receiver may be used on a howler to locate this trouble. This and the howler getting out of adjustment are the only troubles that are liable to occur.

CONDENSER TROUBLE IN THE HOWLER CIRCUIT.

If there is reason for thinking that the condenser is open, put a wire across the terminals to it and make a test. If the howler now works, a new condenser is necessary. If the condenser is short-circuited, the howler will continue to operate satisfactorily, but ringing trouble on the line will result. A new condenser is necessary before the howler is reconnected to the telephone line.

CODE LIST OF PARTS USED IN LATEST MODEL 1317S WALL TELEPHONE.

Only such parts are given below as are liable to be most used for repairs on 1317S wall telephone. When ordering any of these parts give the name of part and code number.

Receiver, 143AW.
Receiver parts:
- Shell, P93518.
- Earpiece, P93519.
- Diaphragm, P95114.

Receiver cords:
- 1317S, 521.
- 1336J, 384.

Transmitter { Old type 353BW. / New type 323BW.
Transmitter cord, 547 and 548.
Transmitter mouthpiece, P84570.
Induction coil, 13.
Condenser, 21W.
Switch hook, 143Y.

Generator:

Generator, 48A.

Parts in generator—

Magnets—

4, P106117.

1 (middle), P136790.

Armature, P129835.

Crank, P140300.

Round rubber bushings for spring assembly, 4823A.

Flat rubber bushings for spring assembly, 4824A.

Spring Assembly—Complete spring assembly for 48A generator.

Ringers:

Ringer (complete), 2,500-ohm, 38BG.

Ringer coils (one only), P133727—1250 ohms.

Armature (complete with clapper), P138638.

Gongs—

Black finish, 26A.

Nickel finish, 17.

Screw for attaching gongs, P13625.

Frame for holding armature, Nos. P108452.

Ringers—Continued.

Permanent magnet, P101702.

Pivot screw N, Figure 4, Nos. P101692.

Lock nut E, Figure 4, Nos. P101699.

Adjustment screw C, Figure 4, Nos. P108454.

Clamping plate, P101706.

Lightning protector:

Type 58B (fuses and protector)—

Fuse (Type 11C).

Protector blocks (copper), 19 and 20.

Micas, 10.

Asbestos mat, 48.

Type 60B (without fuses)—

Protector blocks, 19 and 20.

Micas, 10.

Vacuum protector:

Type 148057—

Base (only), 148056.

Tube (only), 140116.

Howler:

Howler (Type 1C).

Condenser 1 M. F. (Type 21W).

TELEPHONE DON'TS.

Don't allow unguarded guy wires to remain on public road or street.

Don't pull up a tree line too tight when making repairs.

Don't use in repair work any type of tie on the tree lines other than the one shown in Figure 9.

Don't fail to see that all telephones and extension bells on any line have the same resistance ringers.

Don't put a standard indoor telephone set out of doors or in a damp place unless it is properly protected from the weather.

Don't attach any equipment with nails.

Don't think you can make a good ground on any old iron rod, piece of wiring, or junk that may come handy.

Don't expect to get a good ground except in permanently moist earth.

Don't hesitate to pour water around your ground rod frequently.

Don't ring on a line until you have listened in to find out whether the line is busy.

Don't think because the station called fails to answer on the first ring that the line is out of order. The party called may not be at home.

Don't be too ready to blame operating trouble on the instruments. Make proper tests before tearing your telephone set to pieces.

Don't experiment with the interior mechanism of the instruments. Learn all about a telephone; then you won't have to experiment.

Don't stand too far from the transmitter while talking. The lips should almost touch the mouthpiece.

Don't drop the receiver; the shell is made of hard rubber and is brittle.

Don't leave the receiver off the hook for long periods. The batteries are then in use and will soon be exhausted.

Don't fail to post a copy of the "station calls" at every station, close beside the instrument.

Don't fail to keep the list of station calls corrected up to date.

Don't fail to take the batteries out of the portable telephones at the end of the field season.

Don't try to maintain lines without systematic tests.

Don't fail to make at least one general overhauling a year; two are better.

Don't allow fallen trees to accumulate across tree lines. Keep them cut out.

Don't allow brush and foliage to grow into tree lines. Keep the limbs trimmed.

Don't fail to inspect and clean lightning protectors after every electrical storm.

Don't fail to keep a small supply of fuses on hand for replacing those that burn out.

Don't substitute a piece of wire for a fuse except as a temporaty expedient. Replace with a fuse at the first opportunity.

Don't put paper between the protector blocks. Keep a few extra micas on hand.

Don't fail to put in new batteries in all stations at least annually.

Don't replace batteries one cell at a time. Put in an entirely new set.

Don't fail to keep on hand extra fresh dry batteries for use in the portable telephones during the summer months.

Don't fail to see that all connections around the station are properly soldered.

Don't expect binding posts and other nonsoldered connections to remain tight and clean indefinitely. They all have a tendency to work loose, and they often corrode.

Don't try to make repairs to delicate parts of the instruments unless you know how.

Don't oil the generator unless you know how. Improper oiling will ruin the generator and interfere with the service of the entire line.

Don't climb old poles without first making sure that they are not rotten at the butt.

Don't make repairs or handle any wire on the line during electrical storms.

Don't keep old batteries after they have been removed from the telephone sets. Destroy them.

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